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RF3108

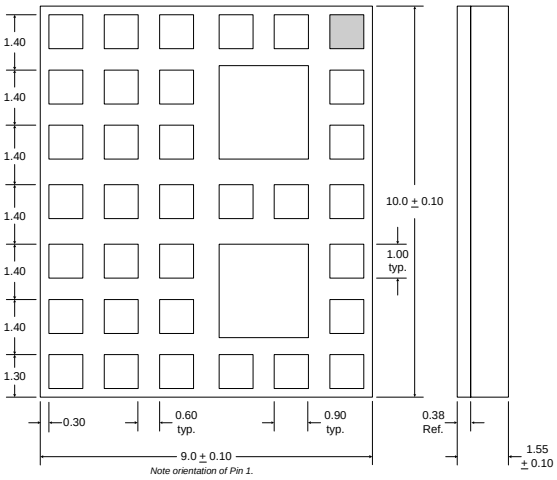
TRIPLE-BAND GSM/DCS/PCS
POWER AMP MODULE

Typical Applications

- 3V Dual-Band/Triple-Band GSM Handsets
- Commercial and Consumer Systems
- Portable Battery-Powered Equipment
- GPRS Compatible

Product Description

The RF3108 is a high-power, high-efficiency power amplifier module offering high performance in GSM or GPRS applications. The device is self-contained with 50Ω input and output terminals. The device is manufactured on an advanced GaAs HBT process, and has been designed for use as the final RF amplifier in GSM/DCS and PCS hand held-digital cellular equipment and other applications in the 880MHz to 915MHz and 1710MHz to 1910MHz bands. On-board power control provides over 70dB of control range with an analog voltage input, and provides power down with a logic "low" for standby operation. The device is packaged in an ultra-small (9mmx10mm) LCC, minimizing the required board space.

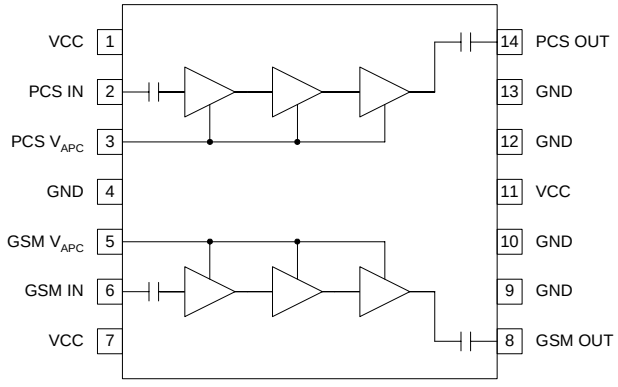


NOTE: Shaded area represents Pin 1.

Package Style: Module

Optimum Technology Matching® Applied

- ☐ Si BJT
- ☑ GaAs HBT
- ☐ GaAs MESFET
- ☐ Si Bi-CMOS
- ☐ SiGe HBT
- ☐ Si CMOS



Functional Block Diagram

Features

- Single 2.9V to 4.7V Supply Voltage
- +35.5dBm GSM Output Pwr at 3.5V
- +33.0dBm DCS/PCS Output Pwr at 3.5V
- 55% GSM and 50% DCS/PCS Efficiency
- Supports GSM, E-GSM and DCS/PCS
- 9mmx10mm Package Size

Ordering Information

RF3108	Triple-Band GSM/DCS/PCS Power Amp Module
RF3108 PCBA	Fully Assembled Evaluation Board

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Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.5 to +6.0	V_{DC}
Power Control Voltage ($V_{APC1,2}$)	-0.5 to +3.0	V
DC Supply Current	2400	mA
Input RF Power	+13	dBm
Duty Cycle at Max Power	50	%
Output Load VSWR	8:1	
Operating Case Temperature	-40 to +85	°C
Storage Temperature	-55 to +150	°C

Caution! ESD sensitive device.

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Overall (GSM Mode)					Temp=+25°C, V_{CC}=3.5V, V_{APCGSM}=2.6V, P_{IN}=6dBm, Freq=880MHz to 915MHz, 25% Duty Cycle, Pulse Width=1154µs
Operating Frequency Range		880 to 915		MHz	
Maximum Output Power	+34.5	35.5		dBm	Temp = 25°C, V_{CC}=3.5V, V_{APCGSM} =2.6V
	+32.0			dBm	Temp=+85°C, V_{CC}=2.9V, V_{APCGSM} =2.6V
Total Efficiency	47	55		%	At $P_{OUT,MAX}$, V_{CC}=3.5V
Input Power for Max Output	+4	+6	+8	dBm	
Output Noise Power			-72	dBm	RBW=100kHz, 925MHz to 935MHz, $P_{OUT} \geq$ 34.5dBm
			-81	dBm	RBW=100kHz, 935MHz to 960MHz, $P_{OUT} \geq$ 34.5dBm
Forward Isolation			-30	dBm	V_{APCGSM}=0.2V, PIN=+8dBm
Second Harmonic		-40	-35	dBc	
Third Harmonic		-50	-43	dBc	
All other non harmonic spurious			-36	dBm	
Input Impedance		50		Ω	
Input VSWR			2.5:1		$P_{OUT,MAX}$-5dB<P_{OUT}<$P_{OUT,MAX}$
Output Load VSWR	8:1				Spurious<-36dBm, V_{APCGSM}=0.2V to 2.6V, RBW=100kHz
Output Load Impedance		50		Ω	Load impedance presented at RF OUT pad
Power Control V_{APC1}					
Power Control “ON”	2.6			V	Max. P_{OUT}, Voltage supplied to the input
Power Control “OFF”	0.2	0.5		V	Min. P_{OUT}, Voltage supplied to the input
Power Control Range		70		dB	$V_{APC1,2}$=0.2V to 2.6V
Gain Control Slope		100		dB/V	P_{OUT}=-10dBm to 35dBm
APC Input Capacitance			10	pF	DC to 2MHz
APC Input Current		4.5	5	mA	V_{APC}=2.6V
			10	µA	V_{APC}=0V
Turn On/Off Time			2	µS	V_{APC}=0 to 2.6V
Overall Power Supply					
Power Supply Voltage		3.5		V	Specifications
	2.9		4.7	V	Nominal operating limits, P_{OUT}<+33dBm
Power Supply Current		2		A	DC Current at $P_{OUT,MAX}$
		1	10	µA	P_{IN}<-30dBm, $V_{APC1,2}$=0.2V, Temp=-40to+85°C

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Overall (DCS/PCS Mode)					Temp=25°C, V_{CC}=3.5V, $V_{APCDCS/PCS}$=2.6V, P_{IN}=6dBm, Freq=1710MHz to 1910MHz, 25% Duty Cycle, Pulse Width=1154µs
Operating Frequency Range		1710 to 1910		MHz	
Maximum Output Power	+32	+33		dBm	Temp=25°C, V_{CC}=3.5V, $V_{APCDCS/PCS}$=2.6V, 1710MHz to 1785MHz
	31.5	32.5		dBm	1850MHz to 1910MHz
	29.0	29.5		dBm	Temp=+85°C, V_{CC}=2.9V, V_{APC}=2.6V, 1850MHz to 1910MHz
	29.5	30		dBm	1710MHz to 1785MHz
Total Efficiency	45	52		%	At $P_{OUT,MAX,}$ V_{CC}=3.5V, 1710MHz to 1785MHz
	40	47		%	At $P_{OUT,MAX,}$ V_{CC}=3.5V, 1850MHz to 1910MHz
Recommended Input Power Range	+4	+6	+8	dBm	
Output Noise Power			-77	dBm	RBW=100kHz, 1805MHz to 1880MHz and 1930MHz to 1990MHz, $P_{OUT} \geq$ 34.5dBm, V_{CC}=3.5V
Forward Isolation		-37	-30	dBm	$V_{APCDCS/PCS}$=0.2V, P_{IN}=+8dBm
Second Harmonic		-60	-45	dBc	$P_{OUT,}$ = +32.5dBm
Third Harmonic		-65	-50	dBc	
All other spurious			-36	dBm	
Input Impedance		50		Ω	
Input VSWR		-	2.5		$P_{OUT,MAX}$-5dB<P_{OUT}<$P_{OUT,MAX}$
Output Load VSWR	8:1				Spurious<-36dBm, $V_{APCDCS/PCS}$=0.2V to 2.6V, RBW=100kHz
Output Load Impedance		50		Ω	Load impedance presented at RF OUT pin
Power Control V_{APC2}					
Power Control “ON”			2.6	V	Max. P_{OUT}, Voltage supplied to the input
Power Control “OFF”	0.2	0.5		V	Min. P_{OUT}, Voltage supplied to the input
Power Control Range	62	68		dB	$V_{APC1,2}$=0.2V to 2.6V, P_{IN}=+8dBm
Gain Control Slope		100		dB/V	P_{OUT}=-10dBm to +33dBm
APC Input Capacitance			10	pF	DC to 2MHz
APC Input Current		4.5	5	mA	V_{APC}=2.6V
			10	µA	V_{APC}=0V
Turn On/Off TIme			100	ns	V_{APC}=0to2.6V
Overall Power Supply					
Power Supply Voltage		3.5		V	Specifications
	2.9		4.7	V	Nominal operating limits, P_{OUT}<+33dBm
Power Supply Current		1.3		A	DC Current at $P_{OUT,MAX}$
		1	10	µA	P_{IN}<-30dBm, $V_{APC1,2}$=0.2V, Temp=-40to+85°C

Pin	Function	Description	Interface Schematic
1	VCC1	Power Supply for the driver stage of the DCS/PCS band.	
2	DCS/PCS IN	RF Input to the DCS/PCS band. This is a 50Ω input.	
3	DCS/PCS V_{APC}	Power control for the pre-amplifier, driver, and output stage of the DCS/PCS band.	
4	GND	Ground connection to overall package.	
5	GSM V_{APC}	Power control for the pre-amplifier, driver, and output stage of the GSM band.	
6	GSM IN	RF input to the GSM band. This is a 50Ω input.	
7	VCC2	Power supply for the driver stage of the GSM band.	
8	GSM OUT	RF output for the GSM band. This is a 50Ω output. The output load line matching is contained internal to the package.	
9	GND	Ground connection to overall package.	
10	GND	Ground connection to overall package.	
11	VCC3	Power supply for the pre-amplifier and output stage for both the DCS/PCS and GSM bands.	
12	GND	Ground connection to overall package.	
13	GND	Ground connection to overall package.	
14	DCS/PCS OUT	RF output for the DCS/PCS band. This is a 50Ω output. The output load line matching is contained internal to the package.	
Pkg Base	GND	Ground connection to overall package.	

Theory of Operation and Application Information

The RF3108 is a triple-band, GSM/DCS/PCS power amplifier with two separate RF inputs and outputs that are internally matched to 50Ω. Pins 2 and 14 of the device provide the RF input and output for the DCS/PCS band, which is optimized for performance between 1710MHz and 1910MHz. Pins 5 and 8 of the device provide the RF input and output for the GSM band, which is optimized for performance between 880MHz and 915MHz. Both bands include an internal DC-blocking capacitor to protect the device from external DC source inputs and block internal DC from exiting the inputs and outputs of the module. The performance is similar to the performance of the RF2173 and RF2174 MIMIC devices used in dual- or triple-band applications. However, the RF3108 module includes the matching and bypass capacitors required for operation internal to the 9mmx10mm module. However, some external components are required to improve stability, isolation and noise power performance. These components are included on the evaluation board and schematic, and will be described in the following paragraphs.

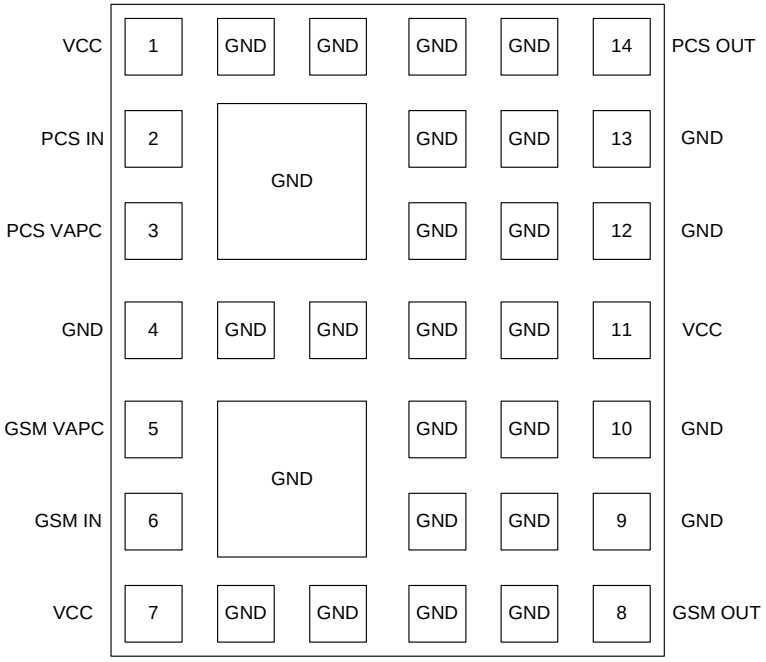
The GSM 900MHz band provides 32dB and the DCS/PCS 1710MHz to 1910MHz band provides 28dB of small signal gain at full output power. Therefore, the drive level required to fully saturate the output is +4dBm for each band. Based upon HBT (Heterojunction Bipolar Transistor) technology, the part requires only a single positive 3V supply to operate to full specification. The DCS/PCS band input is located at pin 2 of the device and requires no external components. The GSM 900MHz band input is located at pin 6 of the device and also does not require external components. However, a 180Ω resistor is included at the input of the GSM band to improve the input impedance and isolation performance at low V_{APC} levels. The output for both high and low bands are internally matched to 50Ω at the output of pin 14 and 8. A 50Ω microstrip should be used to interface to the input and output connections.

Power control for the GSM 900MHz band is provided through pin 5 of the device, and pin 3 for the DCS/PCS band. The V_{APC} inputs do not contain any internal bypass capacitors and will require some external filtering. Because the V_{APC} filtering capacitor is external to the device, the user has the option of choosing a capacitor value that meets the control loop BW and filtering requirement for various applications. In most typical applications with a closed loop power control, the recommended bypass capacitor for this input is approximately 33pF for the GSM band, and 12pF for the DCS/PCS band. However in open loop operation, a 10nF V_{APC} bypass capacitor is recommended for both bands to filter noise from the external V_{APC} source. A 10nF capacitor is installed on pins 3 and 5 on the current evaluation board (see the evaluation board schematic). Noise on the V_{APC} input will degrade the noise power performance of the device, so care should be used to provide a clean V_{APC} input signal. This is especially important when measuring noise power or stability performance.

The voltage supply V_{CC} contains internal bypass capacitors and inductors to filter unwanted noise on the DC supply voltage. However, the main V_{CC} input to the device at pin 11 requires some additional bypass capacitors as shown in the evaluation board schematic. C5 (1uF) and C4 (3.3uF) are required to improve the stability performance.

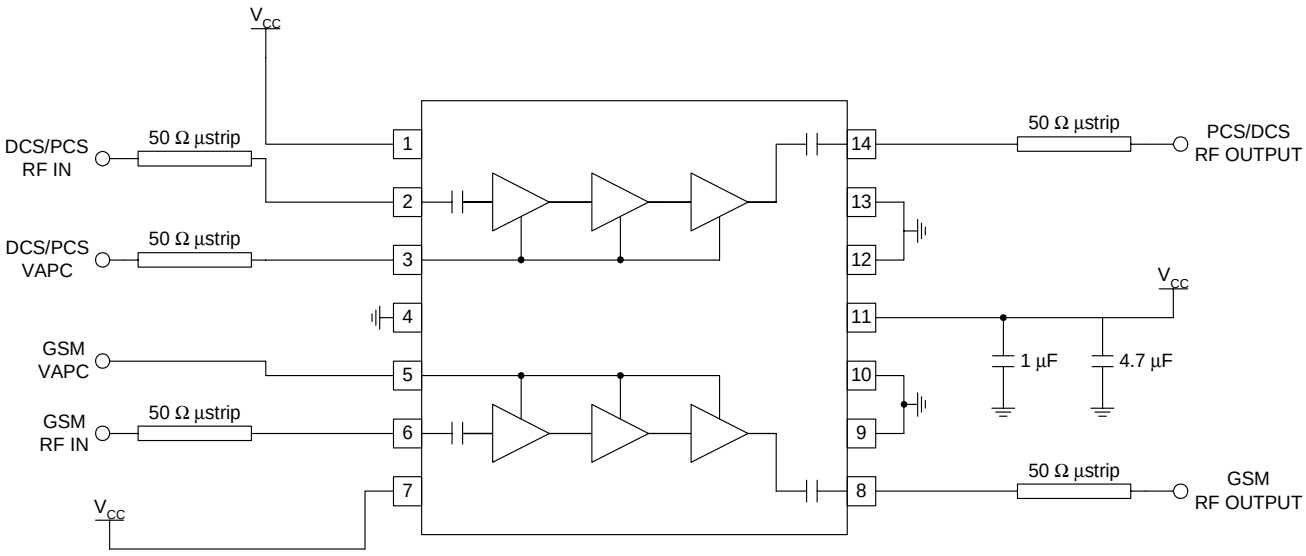
All the internal ground connections are connected to a series of ground pads located on the backside of the package as shown in the pin out diagram. Pins 4, 9, 10, 12, and 13 are also ground connections. The final stages of both bands are connected to the ground pads on the backside of the package. Therefore this ground connection is essential to dissipate heat and to provide proper current flow. Refer to the evaluation board layout as an example of the vias locations and quantity required for proper connection.

Pin Out



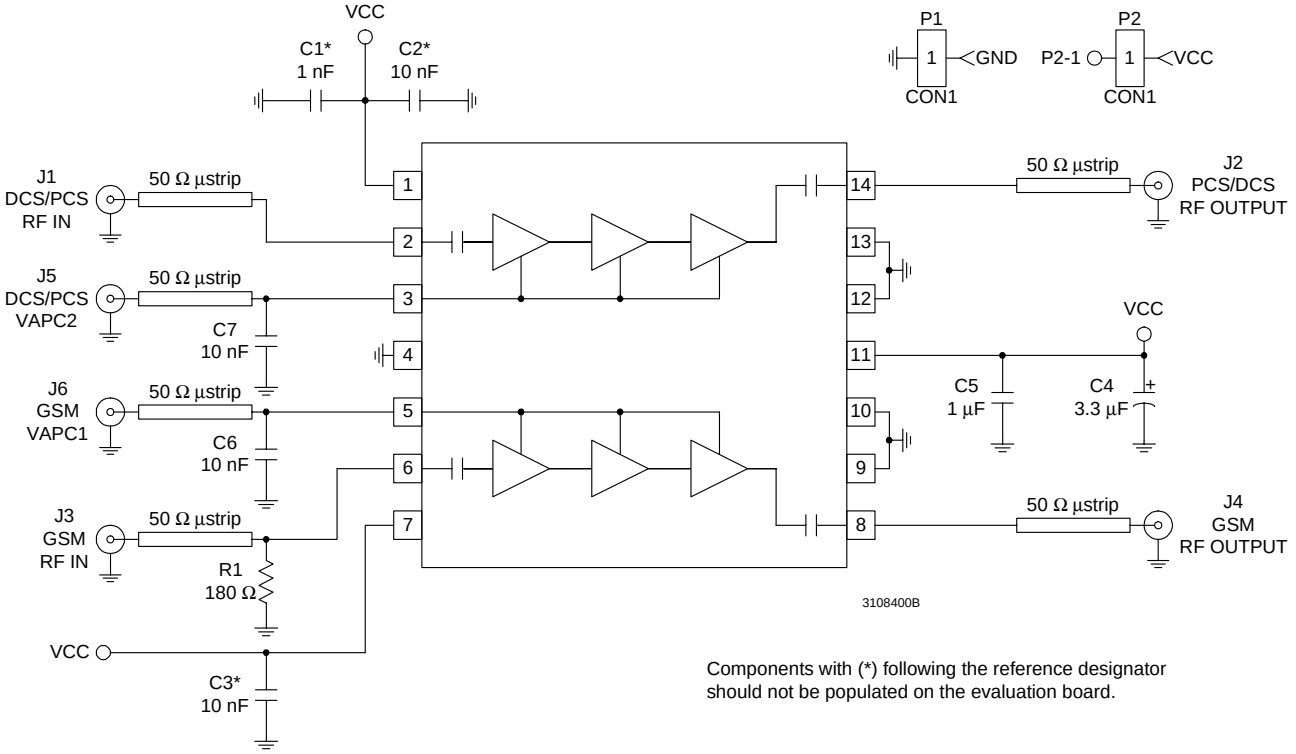
Top View

Application Schematic



Evaluation Board Schematic

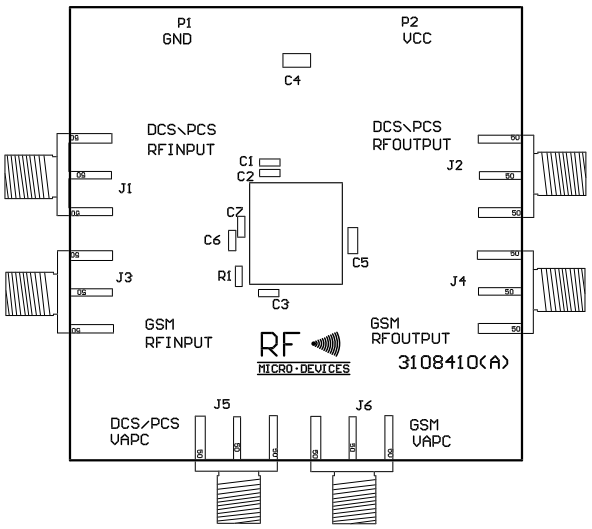
(Download Bill of Materials from www.rfmd.com.)

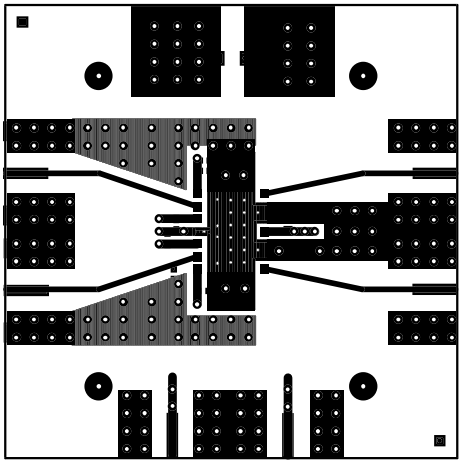


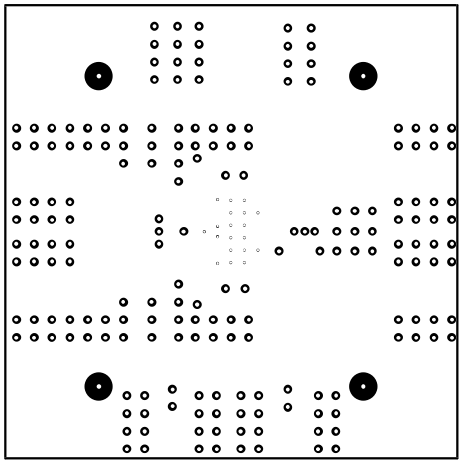
Components with (*) following the reference designator should not be populated on the evaluation board.

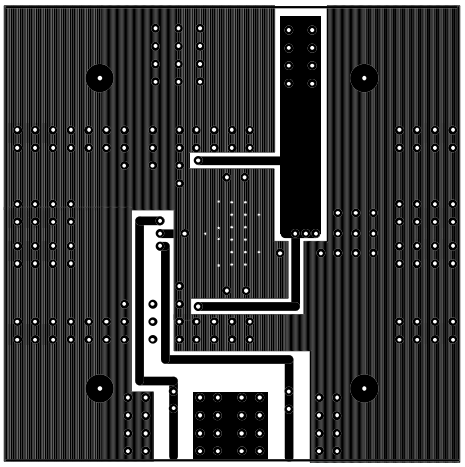
Evaluation Board Layout
Board Size 2.0” x 2.0”

Board Thickness 0.031”; Board Material FR-4; Multi-Layer

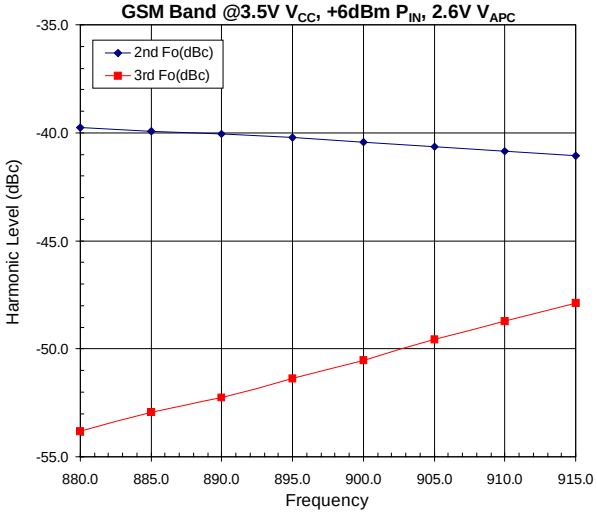




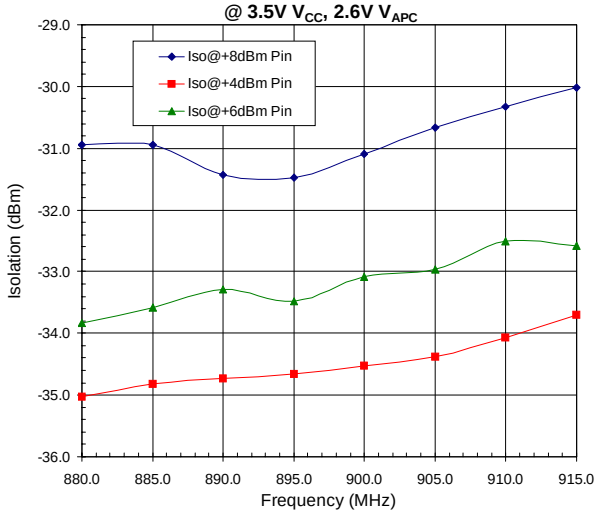




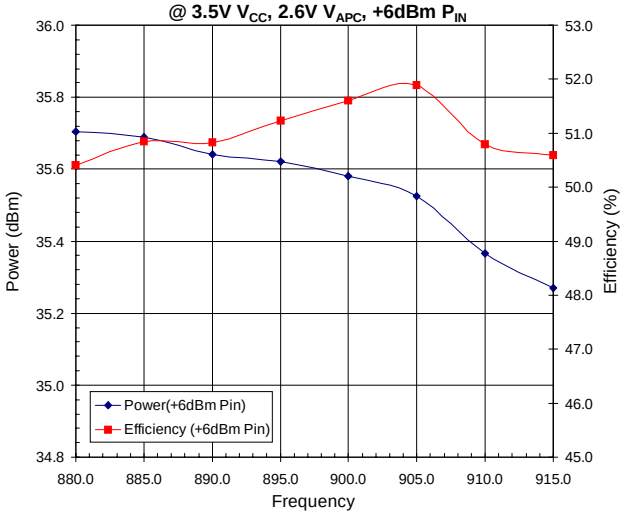
2nd and 3rd Harmonic Performance
GSM Band @3.5V V_{CC}, +6dBm P_{IN}, 2.6V V_{APC}



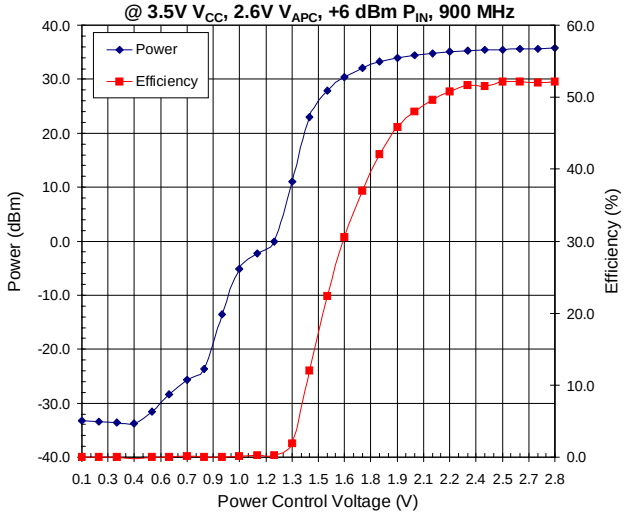
Isolation Performance GSM Band
@ 3.5V V_{CC}, 2.6V V_{APC}



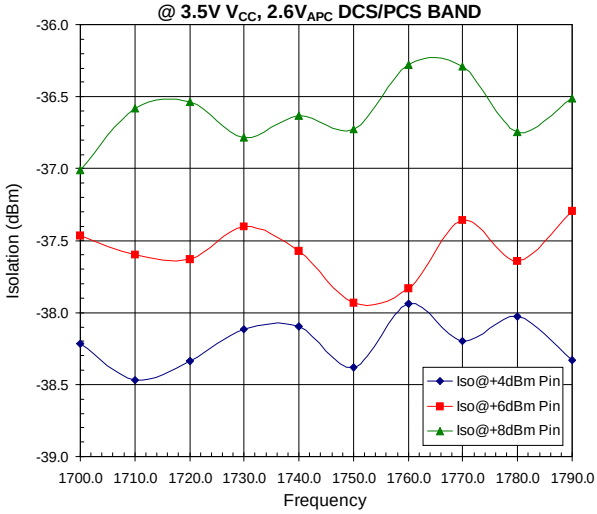
Power and Efficiency Performance
@ 3.5V V_{CC}, 2.6V V_{APC}, +6dBm P_{IN}



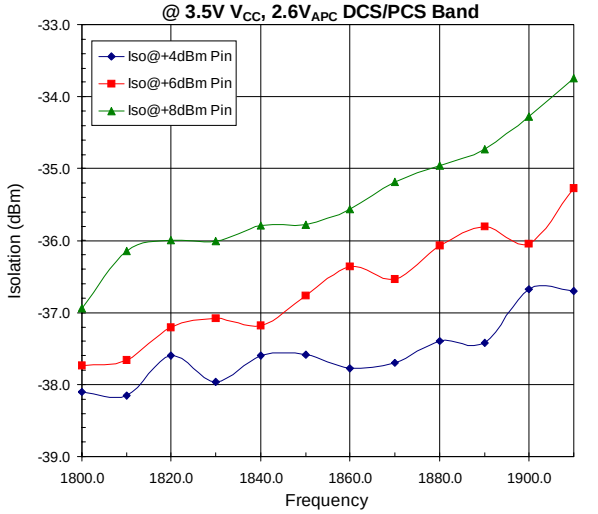
Power Control Response
@ 3.5V V_{CC}, 2.6V V_{APC}, +6 dBm P_{IN}, 900 MHz



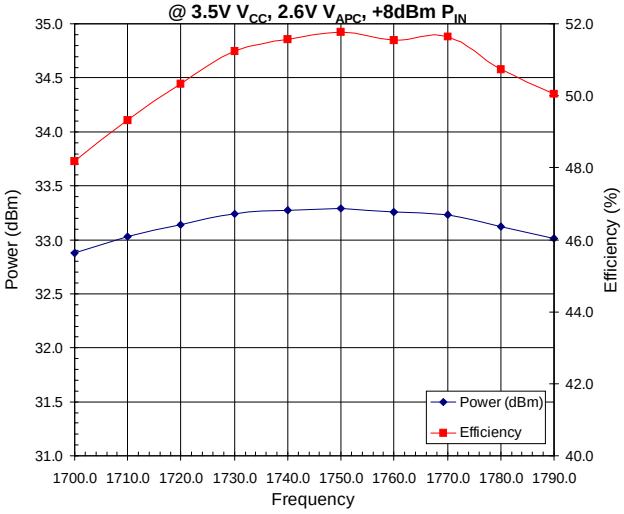
Isolation Performance DCS/PCS Band
@ 3.5V V_{CC}, 2.6V$_{APC}$ DCS/PCS BAND



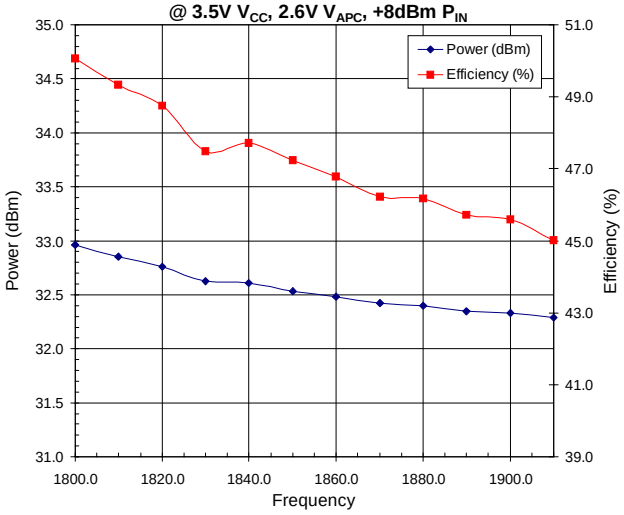
Isolation Performance DCS/PCS Band
@ 3.5V V_{CC}, 2.6V$_{APC}$ DCS/PCS Band



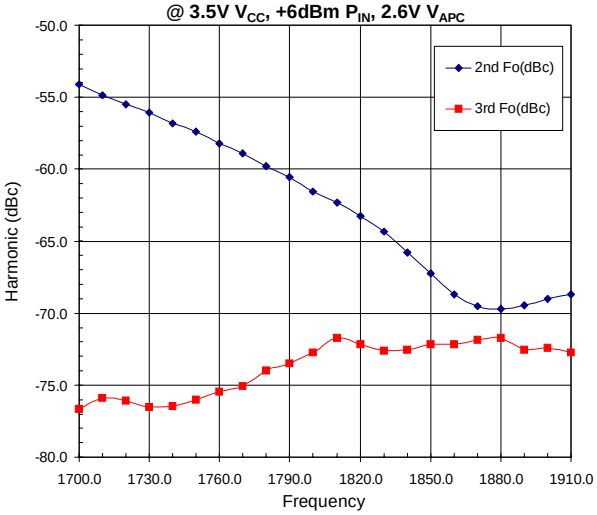
DCS Band Power and Efficient Performance
@ 3.5V V_{CC}, 2.6V V_{APC}, +8dBm P_{IN}



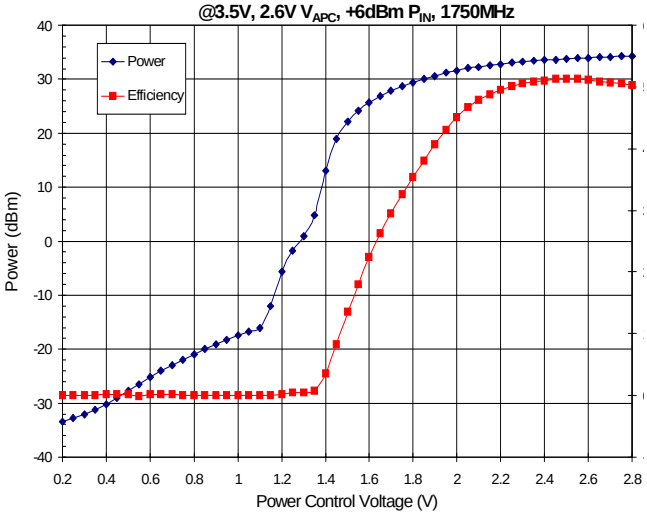
PCS Band Power and Efficiency Performance
@ 3.5V V_{CC}, 2.6V V_{APC}, +8dBm P_{IN}



2nd and 3rd Harmonic Performance (DCS/PCS Band)
@ 3.5V V_{CC}, +6dBm P_{IN}, 2.6V V_{APC}



Power Control Response
@3.5V, 2.6V V_{APC}, +6dBm P_{IN}, 1750MHz



Power Control Response
@3.5V V_{CC}, 2.6V V_{APC}, +6dBm P_{IN}, 1850MHz